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Further Notes on *Eudocima hypermnestra* (Stoll, 1780) in Taiwan (Lepidoptera, Erebidae, Calpinae)

SHIPHER WU¹, MEI-LING LEE², ZEN-BANG XIE³, HSIU-CHUN LEE², HSUEH LEE⁴

¹ National Taiwan Museum, No. 2, Xiangyang Rd, Zhongzheng District, Taipei City, Taiwan. Email: spwu@ntm.gov.tw

² Donghu Elementary School, Taipei City, Taiwan

³ No.40, Ln. 131, Wufu St., East Dist., Chiayi City, Taiwan

⁴ No.23, 24F, Ln. 30, Yixing St., Xizhi Dist., New Taipei City, Taiwan

Abstract. The oblique striped fruit-piercing moth, *Eudocima hypermnestra* (Stoll, 1780), was first recorded from Taiwan in 2021 based on a single female specimen. The present study provides additional information on adult male and immature morphology. The vine with tuberous stems, *Tinospora crispa* (Menispermaceae), a naturalized plant in Taiwan, represents the restricted host of *E. hypermnestra*. This plant is widespread across Taiwan's lowlands, foothills, and mid-elevation areas along roadsides, suggesting a potentially similar distribution for the moth species.

Keywords: subtropical region, primary piercing, naturalized plant

Introduction

The fruit-piercing moth genus *Eudocima* Billberg, 1820, often harbors large, widely distributed species and is also one of the important targets for pest control in fruit tree agriculture (Zilli & Hogenes, 2002). In Taiwan, five species of this genus are well-known to occur (Sugi, 1992). In 2021, *E. hypermnestra* (Stoll, 1780) was first recorded from Taiwan based on a female voucher specimen. At the end of 2021, a valuable live female individual was obtained through sharing on a Facebook citizen science platform by Mr. Der-Sheng Yang (Taipei). The present study provides additional morphology and bionomic information of this species in Taiwan.

Abbreviation:

ESRI Taiwan Endemic Research Institute, Nantou

NTM National Taiwan Museum, Taipei

NMNS National Museum of Natural Science, Taichung

TFRI Insect collection, Taiwan Forestry Research Institute, Taipei

Material and methods

Rearing - A female adult (TMIN3857) collected from New Taipei City was placed in a plastic container measuring 14x14x25 cm. The female moth laid about 80 eggs in the container before being provided with potential larval host plants. In Thailand, *Tinospora crispa* (Menispermaceae) was recorded as the host of *Eudocima hypermnestra* (Robinson et al., 2023) and was regarded as a non-native plant species in Taiwan (Chen et al., 2017). We chose *T. crispa* and other Menispermaceae plants, e.g. *Cocculus orbiculatus*, *Stephania japonica* var. *japonica*, and *Pericampylus formosanus*, to test as potential hosts for the Taiwanese populations. Subsequently, the larvae only fed on *T. crispa*. They fed on leaves but gradually shifted their preference to stems, especially starting from the 4th instar larvae. Pupae were kept in equally-sized containers and maintained in a moist environment using sphagnum moss until adult emergence.

Molecular data - A right mid leg of the fresh specimen was removed and used for acquiring molecular sequences. We followed the methods provided by Wahlberg and Wheat (2008) to obtain a molecular COI sequence.

Image acquisition - The individuals were photographed using a Nikon Z7 digital camera and AF-S Micro Nikkor 60mm F2.8G ED lens with SB5000 flash covering SMDV Speedbox-Flip diffuser. The images were edited in Adobe Photoshop 2023 (Adobe Inc.).

Results

Eudocima hypermnestra (Stoll, 1780) 斑落葉裳蛾 (Figs 1–2, 5–11)

Phalaena Noctua hypermnestra Stoll, 1780, in Cramer, *Uitlandsche Kapellen* 4: 69, pl. 323, figs A. B.

Rhytia hypermnestra: Moore, 1881: 73, pl. 12, fig. 6, larva, pl. 14, figs 4, 4a, imago ♂♀.

Ophideres hypermnestra: Hampson, 1894: 562; Chen, 1982: 3: 362, pl. 109, fig. 2597

Eudocima hypermnestra: Poole, 1989: 400; Yoshimoto, 1995: 73, pl. 115: 4–5; Chen, 1999: 1089, pl. 56: 9; Zilli & Hogenes, 2002: 163; Kononenko & Pinratana, 2005: 30, pl. 4: 3–4.

Specimens examined. TAIWAN. 1 female, New Taipei City, Xindian District, Rd. Anxiang (220 m), 24.964314, 121.486343, leg. S. Wu, TMIN3928 (NTM); 1 male, same locality, reared from egg laid by TMIN3928, emgd. 16. III. 2021, CB1278, slide TMIN3857 (NTM; GenBank accession number OR214914; figs 1); 1 female, same data as the former, SWC2023-0026, TMIN3858 (NTM); 2 females, same data as the former, emgd. 25. II. 2021, TMIN3928 & 3929 (NTM). 1 female, Taipei City, Xiangshan Trail, 25-I-2022, H. Lee, TMIN3947 (NTM).

Diagnosis. The female adults of *Eudocima hypermnestra* (Fig. 2) have multiple white patches on their forewings, which is a unique characteristic among *Eudocima* species in Taiwan. The male adults of *E. hypermnestra* (Fig. 1) have a similar appearance to the male adults of *E. phalonia* (Linnaeus, 1763) (Fig. 3), with both having oblique straight lines on the hindwings. However, the base color of the forewings in male *E. hypermnestra* is dark olive green, while it is brown in male *E. phalonia*. Additionally, the female *E. phalonia* (Fig. 4) can be well distinguished by the presence of a white triangular spot located at the median part of postmedial line of the forewing. The larvae of *E. hypermnestra* (Figs 6–11) have a black body color starting from the third instar, with a matte grayish halo on the dorsal side. In comparison, the mature larvae of *E. phalonia* (Fig. 12) have a brown color with a reddish hue.

Description of the immature stage. Moore (1881) illustrated a mature larva of *E. hypermnestra* with its description. Herein, we describe the morphology of the entire immature stage accompanying images:

Egg (Fig. 5) – Approximately 1.1 mm in diameter, round, and yellowish-white.

1st instar (Fig. 6) – Approximately 6 mm in length, with a cylindrical body shape; head yellow with black ocelli; body coloration yellowish-green with black tubercles; legs and prolegs black.

2nd instar (Fig. 7) – Approximately 20 mm in length, with a cylindrical body shape; head and ocelli black; body coloration black with one pair of distinct orange spots located on the lateral side of the 2nd abdominal segment; a few tiny white spots scattered on the lateral side of thoracic and abdominal segments; legs dark brown, prolegs black.

3rd instar (Fig. 8) – Approximately 32 mm in length, with a cylindrical body shape and the dorsal side of 1st, 2nd, 3rd, and 8th abdominal segments swollen, especially 2nd and 8th ones; head and ocelli black; body coloration black tinged with shiny brown; dense tiny white spots scattered throughout the body, fewer on 2nd and 3rd abdominal segments due to a pair of large "eye spots" located on the dorsolateral side of each segment; "ocellate marks (sensu Holloway, 2005)" black, surrounded by yellow and orange margins, with more distinct margins on the latter; a pair of dorsolateral yellow spots located on 1st and 9th abdominal segments, respectively; a pair of oblique yellow stripes located on each of the 5th to 7th abdominal segments; legs black, prolegs dark grey.

4th instar (Fig. 9) – Approximately 46 mm in length, with patterns similar to the 3rd instar but more distinct, with tiny white spots somewhat tinged with light blue; pinkish-white oblique stripes located on each of the 5th to 7th abdominal segments.

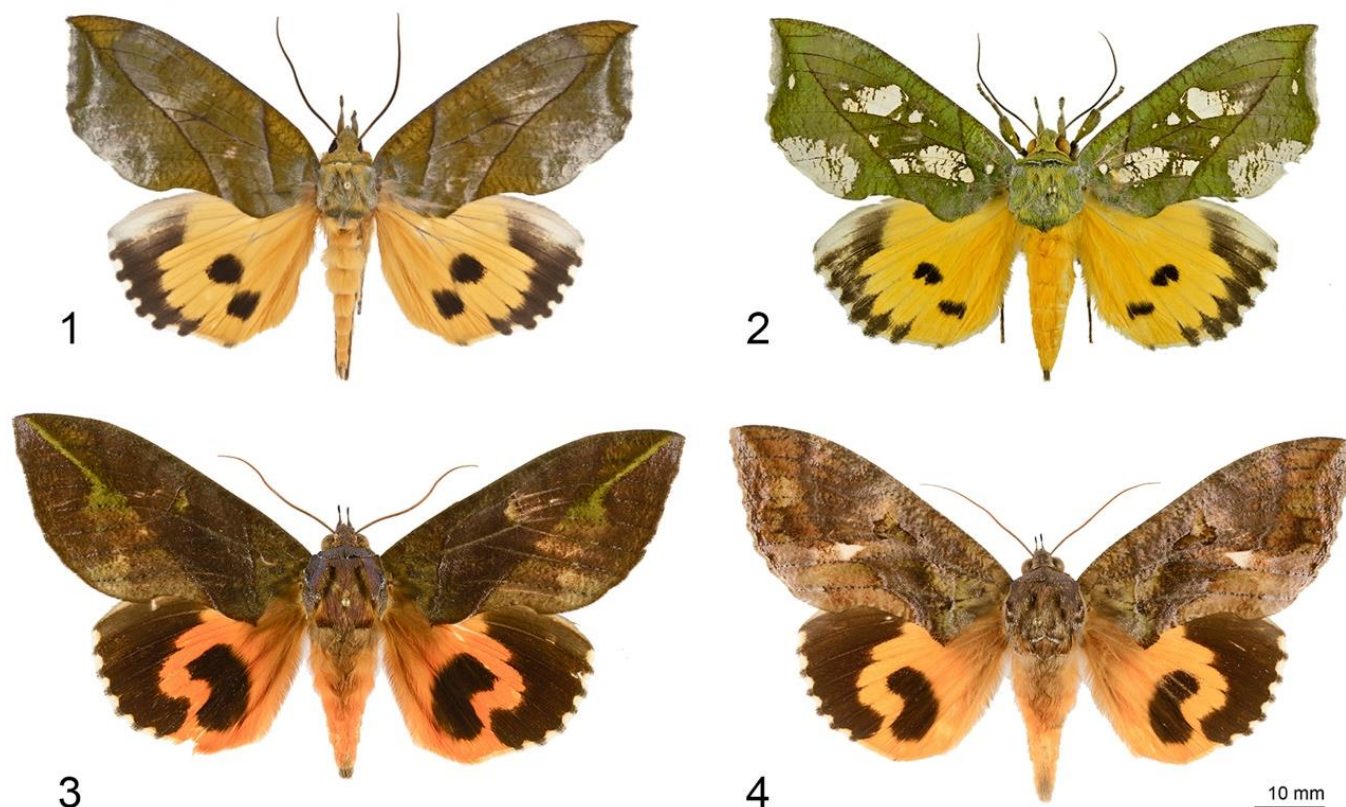
Final instar (Fig. 10) – Approximately 67 mm in length, with patterns similar to the previous instar; a pair of dorsolateral spots located on the 9th abdominal segment reduced and yellowish-white in color.

Pupa (Fig. 11) – Approximately 30 mm, with a typical *Eudocima* form, dark rufous.

DNA barcodes. One sequences (584 bp) was obtained from the male Taiwanese specimen deposited in NTM (TMIN3857). GenBank accession number: OR214914.

Distribution. India, Nepal, Thailand, Vietnam, China, Java, New Guinea, the Philippines, Taiwan (Fu et al., 2021).

Bionomics. According to the voucher specimens recorded in the present study, as well as 26 citizen science data deposited in the database of the Taiwan Moth Information Center (<https://twmoth.tesri.gov.tw/>, accessed on 3 March 2024), this species is now distributed in the lower mountain ranges of northern (Taipei, Taoyuan), central (Taichung) and southern (Kaohsiung) Taiwan (date ranging from August 2021 to February 2024, with adult occurrence months including June to Marc), as well as one citizen science record from Kinmen (June, 2019). Duration of the immature stage: Egg stage approximately 8 days, 1st instar approximately 5 days, 2nd instar approximately 5 days, 3rd instar approximately 6 days, 4th instar approximately 6 days, final instar approximately 7 days, pupal stage approximately 24 days (26 days recorded in Moore, 1881).



Figures 1–4. Habitus of *Eudocima* in Taiwan. 1. *E. hypermnestra* (Stoll, 1780), male (NTM); 2. ditto, female (originally in ESRI; hereafter in NMNS); 3. *E. phalonia* (Linnaeus, 1763), male (TFRI); 4. Ditto, female (TFRI). Photo by Shipher Wu.

Discussion

Zilli et al. (2017) designated the lectotype of *Eudocima hypermnestra* and stated that the separation of *E. hypermnestra* from *E. cocalus* (Cramer, [1777] 1779) can be made merely by external appearance, such as the presence of paired black discal spots on the hindwings. However, the recent molecular phylogenetic study by Borth and Kons (2021) showed that the two species form a clade but are not monophyletic. Our study yielded similar results when comparing sequences from GenBank data. The most similar sequence to the current sampled Taiwanese one (OR214914) is from the western Indian *E. cocalus* (Cramer, [1777] 1779) (KX603659) with 99.83% similarity. In contrast, there is 99.53% similarity with sequences from the Asian continental, specifically *E. hypermnestra* from Vietnam, (ON841754) and Tibet (ON841682).

According to the host tests of *Eudocima hypermnestra* larvae in Taiwan, as well as the recorded hosts in India and Thailand in Robinson et al. (2023), this species exclusively feeds on *Tinospora* (Menispermaceae). Since three other plant families, i.e. Anacardiaceae, Rutaceae and Sapindaceae, listed in Robinson et al. (2023) are not known to be related to such well-known and agricultural significant *Eudocima* species based on current knowledge. The only known *Tinospora* species in Taiwan, *T. crispa*, is reported as a recent introduced and naturalized species (Chen et al., 2016; Chen et al., 2017; Chung & Shao, 2024). Additionally, in the article titled "Catalogue of the Naturalized Flora of Taiwan" published by Wu et al. (2004), this plant genus was not listed. According to the present data recorded on the Citizen Science platform – iNaturalist (https://www.inaturalist.org/observations?taxon_id=344276, access on 3 March, 2024), *T. crispa* has been widespread across Taiwan's lowlands, foothills, and mid-elevation areas along roadsides, suggesting a potential similar distribution for the moth species.

Moore (1881) illustrated the mature larvae of *Rhytia cocale* (= *E. cocalus*) from Java and *E. hypermnestra* ranging from India, Burmah (=Myanmar), Andamans and Ceylon (=Sri Lanka). The former are pale grey, while the latter are of a quite dark coloration similar to the Taiwanese ones. When rearing *E. hypermnestra* from Taiwan, we realized its consistent color form at each instar. In comparison, the appearance of a pale grey mature larva recorded by citizen science data (<https://www.inaturalist.org/observations/67963841>) from west India, the sympatric range of these two species, is consistent with Moore's (1881) illustration of *E. cocalus*. Until now, the host plant of *E. cocalus* has not yet been confirmed, hindering access to the moth-plant distribution pattern between *E. hypermnestra* and *E. cocalus*.



Figures 5–12. Immature stage of *Eudocima* in Taiwan. 5–11. *E. hypermnestra* (Stoll, 1780); 5. Egg on *Tinospora crispa*; 6. 1st instar larvae; 7. 2nd instar; 8. 3rd instar larva; 9. 4th instar larva; 10. Final instar larva; 11. Pupa; 12. Final instar larva of *E. phalonia* (Linnaeus, 1763). Photo by Shipher Wu (5–11); Hua-Hua Lin (12).



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We would like to express our gratitude to Der-Sheng Yang (Taipei) for generously sharing images and providing specific locations, which have allowed us the opportunity to further assess the distribution and biology of the target species. We extend our heartfelt thanks to Mr. Shiu-Shiou Wu (Taipei) for his valuable assistance in specimen collection and larval rearing, to Hua-Hua Lin (Taipei) for providing the larval image of *Eudocima phalonia*, to Gi-Gang Ho (Taichung) for sharing information on the plant family Menispermaceae, to two anonymous for providing valuable comments on the manuscript, and to the support of the 2023 Museum Smart Upgrade Demonstration Project (no. 112-0307-10-30-01), Ministry of Culture of Taiwan, which funds the molecular operation.

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臺灣產斑落葉裳蛾之後續註記（鱗翅目：裳蛾科：壺裳蛾亞科）

吳士緯¹、李美玲²、謝振邦³、李秀純²、李雪⁴

¹ 國立臺灣博物館 臺北市襄陽路2號 Email: spwu@ntm.gov.tw

² 臺北市東湖國民小學

³ 嘉義市東區五福街131巷40號

⁴ 嘉義東區五峰路131巷40號

⁵ 新北市汐止區宜興街30巷23號24樓

摘要: 斑落葉裳蛾 (*Eudocima hypermnestra* (Stoll, 1780)) 於 2021 年首次基於一雌性標本紀錄分布於臺灣。本研究提供了在臺灣雄成蟲與幼生期形態的延伸資訊。本研究確認斑落葉裳蛾之寄主植物侷限於瘤莖藤 (*Tinospora crispa*; 防己科) 此一已知歸化於臺灣的植物，這種植物廣泛分布於臺灣低地、淺山與中高海拔地區的路旁，也因此可預期斑落葉裳蛾的分布格局。

關鍵詞: 亞熱帶地區、主動刺吸式、歸化植物



First Record of *Amblyomma geoemydae* (Cantor) (Ixodida: Ixodidae) on *Cuora couro* (Sunda box turtle) (Testudines: Geoemydidae) in the Philippines

ACE KEVIN S. AMARGA^{1, 2, 3}, PETER JOHN CACAYAN⁴

¹Biodiversity Program, Taiwan International Graduate Program, Biodiversity Research Center, Academia Sinica, Nangang District, Taipei 11529, Taiwan. Email: ace_amarga061@yahoo.com

²School of Life Science, National Taiwan Normal University- Gongguan Campus, Wenshan District, Taipei 11677, Taiwan

³International Union for Conservation of Nature Species Survival Commission (IUCN SSC) Parasite Specialist Group

⁴Marshland Documentation Services, Puerto Princesa, Palawan, Philippines

Abstract. The first definitive record of *Amblyomma geoemydae* (Cantor) in the Philippines was based on the specimens collected from *Cyclemys dentata* (Gray) (Asian leaf turtle) in El Nido, Palawan. In this report, we present the first documentation of *A. geoemydae* parasitism on the Sunda box turtle (*Cuora couro*) in the Philippines. This report underscores the ecological breadth of *A. geoemydae* and suggests potential implications for the health and conservation of native freshwater turtle species in the Philippines.

Keywords: *Amblyomma geoemydae*, *Cuora*, Palawan, Philippines.

Native Philippine freshwater Testudines previously included six species, belonging to the families Trionychidae (*Dogania subplana*, and *Pelochelys cantorii*) and Geoemydidae (*Cuora amboinensis*, *Cyclemys dentata*, *Heosemys spinosa*, and *Siebenrockiella leytensis*) (Diesmos et al., 2008). Recently, Blanck et al. (2023) revised the *Cu. amboinensis* species complex (Southeast Asian box turtle), leading to the recognition of two distinct species in the Philippines. The newly described *Cu. philippinensis* (Philippine box turtle) is endemic to the major islands excluding Palawan and the Sulu archipelago. Meanwhile, populations previously classified as *Cu. amboinensis* in Palawan and the Sulu archipelago have been reclassified as *Cuora couro* (Sunda box turtle). Ticks represent significant ectoparasites associated with freshwater turtles, with the first definitive record of turtle tick in the Philippines reported by Amarga et al. (2022) based on specimens collected from Palawan Island. This paper contributes to the field by presenting the first documentation of tick species associated with *Cu. couro* within the Philippine context.

On 31 January 2024, an adult specimen of *Cuora couro* from the Victoria-Anepahan Mountain Range (Palawan Island) was collected in a shallow stream tributary. Upon closer inspection, a tick was observed attached to the skin folds near the forearm (Fig. 1A). The tick was carefully collected, preserved in 95% ethanol, and examined under a stereomicroscope. The specimen was identified as an unengorged adult *Amblyomma geoemydae*, a turtle tick widespread in Southeast Asia (Amarga et al., 2022). The specimen will be deposited at the National Taiwan Normal University.

Family Ixodidae Koch
Genus *Amblyomma* Koch

Amblyomma geoemydae (Cantor, 1847) (Fig. 1A-B)

Material examined: PHILIPPINES: PALAWAN: On *Cuora couro*: 1♀, Victoria-Anepahan Mountain Range, Sitio Bethlehem, Barangay Princess Urduja, Narra municipality, 31.I.2024, leg. PJ Cacayan.

Amblyomma geoemydae is a reptile-associated tick endemic to the Old World and occurs from South to Southeast Asia, extending to Taiwan, Japan, and southern China. This species is primarily ectoparasitic on Testudines, especially members of the families Geoemydidae and Testudinidae (Robbins et al., 2006; Amarga et al., 2022). In facultative occurrences, *A. geoemydae* has been recorded on squamate reptiles, birds, and even mammals (Robbins et al., 2006). In the Philippines, this species has been reported on *Cyclemys dentata* by Amarga et al. (2022) from specimens collected in El Nido, Palawan. Our account of *Cu. couro* represents an additional confirmed host record for *A. geoemydae* in the Philippines. Additionally, *A. geoemydae* is also expected to occur on islands north of mainland Palawan, including Busuanga and Culion. Furthermore, it is also expected that *A. geoemydae* can parasitize the critically endangered endemic species *Siebenrockiella leytensis* (Philippine forest turtle) in Palawan, as this species was reported to share same habitat type with *Cy. dentata* and *Cu. couro*. Additionally, potential parasitism of *A. geoemydae* on the newly described *Cu. philippinensis* also merits investigation.



Figure 1. Female *Amblyomma geoemydae* (B) and its host, *Cuora couro* (Sunda box turtle) (A) from Palawan Island, the Philippines.

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菲律賓的嗜龜花蜱 (*Amblyomma geoemydae*) (真蜱目：硬蜱科) 寄生於 *Cuora couro* (龜鱉目：地龜科) 之首次紀錄

艾斯^{1,2,3}、彼得·約翰·卡卡延⁴

¹中央研究院生物多樣性中心 生物多樣性臺灣國際研究生博士學位學程 11529 臺北市南港區

E-mail: ace_amarga061@yahoo.com

²國立臺灣師範大學生命科學專業學院 11677 臺北市文山區

³國際自然保護聯盟物種存續委員 (IUCN SSC) 寄生蟲專家組

⁴Marshland Documentation Services, Puerto Princesa, Palawan, 菲律賓

摘要：嗜龜花蜱 (*Amblyomma geoemydae*) 在菲律賓的首次明確紀錄是基於 El Nido 在巴拉望採集到的 *Cyclemy dentata* (地龜科) 標本上。在本報告中，我們首次記錄嗜龜花蜱寄生在菲律賓的 *Cuora couro* (地龜科) 上，顯示嗜龜花蜱的生態廣度，並對菲律賓原生淡水龜物種的健康和保育可能產生的影響。

關鍵詞：嗜龜花蜱、閉殼龜屬、巴拉望、菲律賓



Notes on the Oviposition Behavior and Early Egg Stage of *Callidula attenuata* (Moore, 1879) (Lepidoptera: Callidulidae)

WEI-CHUN CHANG¹, SHIPHER WU^{2,*}

¹ Fisheries Agency, Ministry of Agriculture, 6F., No.100, Sec. 2, Heping W. Rd., Zhongzheng Dist., Taipei City, Taiwan

² National Taiwan Museum, No. 2, Xiangyang Rd, Zhongzheng District, Taipei City, Taiwan.

* Corresponding author: spwu@ntm.gov.tw

Abstract. The oviposition behavior and early egg stage of *Callidula attenuata* (Moore, 1879) are described based on material collected in Taipei City, Taiwan.

Keywords: Obtectomera, Polypodiopsida, dusk-activity, moth

The family Callidulidae is known for its members' exclusive feeding on true ferns (Polypodiopsida) (Yen & Wu, 2009). While there have been descriptions of the larval stages within the subfamily Callidulinae, information on the morphology of the egg stage is sparse. Holloway (1998) reported that the eggs of Calliduline are laid on leaf margins. Nishio (1987) described the egg stage of the Japanese *Pterodecta felderi* (Bremer, 1864) as characterized by an oblate spheroid shape, with diameters ranging from 0.8 to 1.5 mm, a yellowish-white hue and semi-transparent patterns. Holloway (1998), citing unpublished data from Bell, recorded the eggs of *Tetragonus* Geyer, 1832, as being flat, scale-like, and laid in loose clusters; further details of the life cycle and egg information of *T. catamitus* Geyer, 1832 were provided by Young & Wu (2023). The type genus of Callidulinae, i.e., *Callidula* Hübner, 1819, however, has not yet been described. To the best of the author's knowledge, this article represents the first description of the egg morphology and oviposition behavior of the female *Callidula* moth.

Callidula attenuata (Moore, 1879) 帶錨紋蛾 (Figs. 1–3)

Description

Egg (n= 2; Figs 2, 3) – ca. 1.5 mm on the long side; dorsoventrally flattened, yellow, elliptic with irregular margin.

Notes on the original name combination and the female oviposition behavior

The original name combination of this species is *Datanga attenuata* Moore, 1879. Yen and Wu (2009) erroneously gave it as “*Petavia attenuata* Moore, 1879”. The observation of female oviposition behavior (Fig. 1) was made at Baoshanxi (25°01'49.5"N 121°34'52.5"E), Songshan District, Taipei City, Taiwan, on February 4, 2024, from 16:29 to 16:30. The female was observed flying among low grassy slope plants, then alighting on a fully unfurled tender leaf of *Microlepia strigosa* (Thunb.) C. Presl (Dennstaedtiaceae). It moved slightly above the leaf and then fluttered its wings to change its position to another frond on the same plant, moving underneath the frond. The abdomen bent into a hook shape, and then it extended an ivory-colored ovipositor. After the female flew away, a pale yellow-green, droplet-shaped egg was observed on each of the two small fronds on the fern leaf.

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Figures 1–3. The oviposition behavior and early egg stage of *Callidula attenuata* (Moore, 1879) on *Microlepidia strigosa* (Thunb.) C. Presl (Dennstaedtiaceae) at Songshan, Taipei City, Taiwan. 1. Oviposition behavior of a female specimen, observed on February 4, 2024, between 14:29 and 14:30; 2. The first egg laid by the female; 3. The second egg laid by the female. Photo by Wei-Chun Chang (1); Shipher Wu (2, 3).

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帶錨紋蛾的產卵行為與卵初期註記（鱗翅目：錨紋蛾科）

張維君¹、吳士緯^{2,*}

¹ 農業部漁業署 臺北市中正區和平西路二段 100 號 6 樓

² 國立臺灣博物館 臺北市襄陽路 2 號

* 通訊作者：spwu@ntm.gov.tw

摘要：本文描述基於臺灣臺北市所觀察到的帶錨紋蛾產卵行為與早期卵期形態。

關鍵詞：合肢類、水龍古綱（真蕨綱）、黃昏活動、蛾類

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來稿請寄送：taisocinh@gmail.com